CLAIMS

1. A radiation patterning tool comprising:

a feature pattern having a periphery and configured to impart a first rotation in phase to a wavelength of light passing through the feature pattern; and

a rim along a portion of the feature pattern periphery but not along an entirety of the feature pattern periphery; the rim being configured to impart a second rotation in phase to the wavelength of light when the wavelength passes through the rim; the second rotation in phase being from about 170 degrees to about 190 degrees relative to the first rotation in phase.

2. The radiation patterning tool of claim 1 wherein the second rotation in phase is about 180 degrees relative to the first rotation in phase.

3. The radiation patterning tool of claim 1 wherein the feature pattern has a rectangular shape comprising two pairs of opposing sides, and wherein the rim is provided along both opposing sides of one pair of the opposing sides of the rectangular shape and not on either of the opposing sides of the other pair of the opposing sides.

4. The radiation patterning tool of claim 1 wherein the feature pattern has a shape comprising a plurality of sides, and wherein the rim is not along at least one of the sides.

5. The radiation patterning tool of claim 1 comprising a substrate which includes a quartz base, a first phase shifting layer over the quartz base, a second phase shifting layer over the first phase shifting layer and having a different composition than the first phase shifting layer, and an opaque material over the second phase shifting layer; and wherein:

the feature pattern comprises a pattern etched through the first phase shifting layer, second phase shifting layer, and opaque layer; and

the rim comprises a pattern etched through the opaque layer and the second phase shifting layer, and to the first phase shifting layer.

6. The radiation patterning tool of claim 5 wherein the first phase shifting layer attenuates the light more than the second phase shifting layer.

7. The radiation patterning tool of claim 5 wherein:

the first phase shifting layer comprises molybdenum and silicon; and

the second phase shifting layer comprises silicon and one or both of oxygen and nitrogen.

8. The radiation patterning tool of claim 7 wherein the opaque layer comprises chromium.

9. The radiation patterning tool of claim 1 comprising a substrate which includes a quartz base, a first phase shifting layer over the quartz base, a second phase shifting layer over the first phase shifting layer and having a different composition than the first phase shifting layer, and an opaque material over the second phase shifting layer; and wherein:

the feature pattern includes a pattern etched through the first phase shifting layer, second phase shifting layer, and opaque layer, and into the base; and

the rim includes a pattern etched through the opaque layer and to the second phase shifting layer.

10. The radiation patterning tool of claim 9 wherein the first phase shifting layer attenuates the light more than the second phase shifting layer.

11. The radiation patterning tool of claim 9 wherein:

the first phase shifting layer comprises molybdenum and silicon; and

the second phase shifting layer comprises silicon and one or both of oxygen and nitrogen.

12. A radiation patterning tool comprising:

an array of feature patterns arranged in rows and columns; the feature patterns being configured rotate a phase of a wavelength of light as the light passes through the feature patterns; the feature patterns including a first type which imparts a first rotation to the phase, and a second type which imparts a second rotation to the phase, the second rotation being from about 170 degrees to about 190 degrees relative to the first rotation; the two types of feature patterns alternating with one another along the rows of the array;

a plurality of first rims configured to impart the first rotation to the phase of the wavelength of light, the first rims being along edges of the second type of feature patterns;

a plurality of second rims configured to impart the second rotation to the phase of the wavelength of light, the second rims being along edges of the first type of feature patterns; and

the first and second rims being along columns of the array.

13. The radiation patterning tool of claim 12 wherein the two types of feature patterns do not alternate with one another along the columns of the array.

14. The radiation patterning tool of claim 12 wherein the two types of feature patterns do not alternate with one another along the columns of the array, wherein adjacent feature patterns along the columns are separated from one another by a distance, and wherein the individual rims extend an entirety of the distance between adjacent feature patterns along the columns of the array.

15. The radiation patterning tool of claim 12 further comprising a plurality of side-lobe-suppressing patterns between adjacent rims along columns of the array.

16. The radiation patterning tool of claim 12 further comprising a plurality of side-lobe-suppressing patterns; individual side-lobe-suppressing patterns being between adjacent rims along columns of the array; the individual side-lobe-suppressing patterns being configured to rotate the wavelength of light by from about 170 degrees to about 190 degrees relative to the rotation imparted to the light by the rims on either side of the individual side-lobe-suppressing patterns.

17. The radiation patterning tool of claim 16 wherein adjacent rims along the columns are separated from one another by a distance, and wherein the individual side-lobe-suppressing patterns extend an entirety of the distance between adjacent rims along the columns of the array.

18. The radiation patterning tool of claim 16 wherein adjacent rims along the columns are separated from one another by a distance, and wherein the individual side-lobe-suppressing patterns do not extend an entirety of the distance between adjacent rims along the columns of the array.

19. The radiation patterning tool of claim 12 wherein the two types of feature patterns alternate with one another along the columns of the array.

20. The radiation patterning tool of claim 12 wherein two first rims are matched with each of the second type of feature patterns; and wherein two of the second rims are matched with each of the first type of feature patterns.

21. The radiation patterning tool of claim 12 wherein the second rims are not along rows of the array.

22. The radiation patterning tool of claim 12 wherein the first and second rims are not along rows of the array.

23. The radiation patterning tool of claim 12 comprising a quartz base, a first phase shifting layer over the quartz base, a second phase shifting layer over the first phase shifting layer and having a different composition than the first phase shifting layer, and an opaque material over the second phase shifting layer; and wherein:

the first type feature patterns are patterns etched through the first phase shifting layer, second phase shifting layer, and opaque layer; and

the second type feature patterns are patterns etched through the first phase shifting layer, second phase shifting layer, and opaque layer, and into the base.

24. The radiation patterning tool of claim 23 wherein:

the first rims are patterns etched through the opaque layer and the second phase shifting layer, and to the first phase shifting layer; and

the second rims are patterns etched through the opaque layer and to the second phase shifting layer.

25. The radiation patterning tool of claim 23 wherein the first phase shifting layer attenuates the light more than the second phase shifting layer.

26. The radiation patterning tool of claim 23 wherein:

the first phase shifting layer comprises molybdenum and silicon; and

the second phase shifting layer comprises silicon and one or both of oxygen and nitrogen.

27. A method of forming a radiation patterning tool, comprising:

providing a substrate;

forming a feature pattern supported by the substrate; the feature pattern having a periphery; the feature patterned being configured to impart a first rotation in phase to a wavelength of light passing through the feature pattern; and

forming a rim supported by the substrate; the rim being along a portion of the feature pattern periphery but not along an entirety of the feature pattern periphery; the rim being configured to impart a second rotation in phase to the wavelength of light when the wavelength passes through the rim; the second rotation in phase being from about 170 degrees to about 190 degrees relative to the first rotation in phase.

28. The method of claim 27 wherein the substrate comprises a material transparent the wavelength of light, wherein a layer opaque to the wavelength of light is provided over the substrate, and wherein the feature pattern and rim are formed by:

forming a layer of photoresist over the opaque material; a first portion of the photoresist being over a defined feature pattern location, and a second portion of the photoresist being over a defined rim location;

removing the first portion of the photoresist to expose a first segment of the layer in the feature pattern location;

removing the exposed first segment of the layer and etching into the substrate to form an opening in the feature pattern location of the substrate;

after forming the opening in the feature pattern location, removing the second portion of the photoresist to expose a second segment of the layer in the rim location; and

removing the exposed second segment of the layer from the rim location.

29. The method of claim 28 wherein the substrate consists essentially of quartz, and wherein the layer opaque to the wavelength is formed physically against the quartz of the substrate and comprises chromium.

30. A method of forming a radiation patterning tool, comprising:

providing a substrate;

forming a first feature pattern supported by the substrate; the first feature pattern having a periphery; the first feature patterned being configured to impart a first rotation in phase to a wavelength of light when the wavelength passes through the first feature pattern;

forming a first rim supported by the substrate; the first rim being along a portion of the first feature pattern periphery but not along an entirety of the first feature pattern periphery; the first rim being configured to impart a second rotation in phase to the wavelength of light when the wavelength passes through the first rim; the second rotation in phase being from about 170 degrees to about 190 degrees relative to the first rotation in phase;

forming a second feature pattern supported by the substrate; the second feature pattern having a periphery; the second feature patterned being configured to impart a third rotation in phase to the wavelength of light passing through the second feature pattern; the third rotation in phase being from about 170 degrees to about 190 degrees relative to the first rotation in phase;

forming a second rim supported by the substrate; the second rim being along a portion of the second feature pattern periphery but not along an entirety of the second feature pattern periphery; the second rim being configured to impart a fourth rotation in phase to the wavelength of light when the wavelength passes through the second rim; the fourth rotation in phase being from about 170 degrees to about 190 degrees relative to the third rotation in phase.

31. The method of claim 30 wherein the first and second feature patterns are arranged in rows and columns; wherein the first and second feature patterns alternate with one another along the rows of the array; and wherein the first and second rims are along columns of the array.

32. The method of claim 31 wherein the first and second feature patterns do not alternate with one another along the columns of the array.

33. The method of claim 31 wherein the first and second feature patterns alternate with one another along the columns of the array.

34. The method of claim 30 wherein the substrate comprises a material transparent the wavelength of light, wherein a layer opaque to the wavelength of light is provided over the substrate, and wherein the first and second feature patterns and first and second rims are formed by:

forming a layer of photoresist over the opaque material; a first portion of the photoresist being over a first defined feature pattern location, a second portion of the photoresist being over a first defined rim location; a third portion of the photoresist being over a second defined feature pattern location, and a fourth portion of the photoresist being over a second defined rim location;

removing the first and fourth portions of the photoresist to expose segments of the layer in the first feature pattern location and second rim location;

removing the exposed segments of the layer from the first feature pattern location and second rim location; and etching into the substrate to form openings in the first feature pattern location and second rim location of the substrate;

after forming the openings in the first feature pattern location and second rim location, removing the second and third portions of the photoresist to expose segments of the layer in the first rim location and second feature pattern location; and

removing the exposed segments of the layer from the first rim location and second feature pattern location.

35. The method of claim 34 further comprising, prior to removing the exposed segments of the layer from the first rim location and second feature pattern location; implanting a dopant into the first feature pattern location and second rim location.

36. The method of claim 35 wherein the dopant comprises boron, indium, arsenic, antimony or phosphorus.

37. The method of claim 30 wherein the substrate comprises a material transparent the wavelength of light, wherein a layer opaque to the wavelength of light is provided over the substrate, and wherein the first and second feature patterns and first and second rims are formed by:

forming a layer of photoresist over the opaque material; a first portion of the photoresist being over a first defined feature pattern location, a second portion of the photoresist being over a first defined rim location; a third portion of the photoresist being over a second defined feature pattern location, and a fourth portion of the photoresist being over a second defined rim location;

removing the first and third portions of the photoresist to expose segments of the layer in the first and second feature pattern locations;

removing the exposed segments of the layer from the first and second feature pattern locations; and etching into the substrate to form openings in the first and second feature pattern locations of the substrate;

after forming the openings in the first and second feature pattern locations, removing the second and fourth portions of the photoresist to expose segments of the layer in the first and second rim locations; and

removing the exposed segments of the layer from the first and second rim locations.

38. The method of claim 37 wherein the substrate consists essentially of quartz, and wherein the layer opaque to the wavelength is formed physically against the quartz of the substrate and comprises chromium.

39. The method of claim 37 wherein the substrate comprises a quartz base, a first phase shifting layer over the quartz base, and a second phase shifting layer over the first phase shifting layer and having a different composition than the first phase shifting layer.

40. The method of claim 39 wherein the first phase shifting layer comprises molybdenum and silicon; and wherein the second phase shifting layer comprises silicon and one or both of oxygen and nitrogen.

41. The method of claim 39 wherein the opaque material is physically against the second phase shifting layer.

42. The method of claim 39 wherein the opening in the first feature pattern location is extended to no deeper than an upper surface of the quartz base, and wherein the opening in the second feature pattern location is extended into the quartz base.

43. The method of claim 39 wherein the openings in the first and second feature pattern locations are extended into the quartz base; and further comprising:

forming a protective mask over the first feature pattern location and first rim location;

while the protective mask is over the first feature pattern location and first rim location, extending the opening in the second feature pattern location and etching into the second phase shifting layer of the substrate to form an opening in the second rim location; and

removing the protective mask from over the first feature pattern location and first rim location.

44. The method of claim 37 wherein the substrate comprises a quartz base, an attenuating layer over the quartz base, and a phase shifting layer over the attenuating layer and having a different composition than the attenuating layer.

45. The method of claim 44 wherein the attenuating layer comprises one or more of Cr, Mo and Al; and wherein the phase shifting layer comprises silicon and one or both of oxygen and nitrogen.

46. The method of claim 44 wherein the openings in the first and second feature pattern locations are extended to an upper surface of the quartz base; and further comprising:

forming a protective mask over the first feature pattern location and first rim location;

while the protective mask is over the first feature pattern location and first rim location, extending the opening in the second feature pattern location into the substrate, and forming an opening in the second rim location which extends to an upper surface of the attenuating layer; and

removing the protective mask from over the first feature pattern location and first rim location.

47. The method of claim 37 further comprising, after removing the exposed segments of the layer from the first and second rim locations:

forming a protective mask over the first feature pattern location and first rim location;

while the protective mask is over the first feature pattern location and first rim location, extending the opening in the second feature pattern location and etching into the substrate to form an opening in the second rim location; and

removing the protective mask from over the first feature pattern location and first rim location.

48. The method of claim 47 wherein the protective mask comprises photoresist.

49. The method of claim 37 further comprising, after removing the exposed segments of the layer from the first and second rim locations:

forming a protective mask over the first feature pattern location and first rim location;

while the protective mask is over the first feature pattern location and first rim location, implanting a dopant into the second rim location and second feature pattern location; and

removing the protective mask from over the first feature pattern location and first rim location.

50. The method of claim 49 wherein the dopant comprises phosphorus, indium, arsenic, antimony or boron.

51. The method of claim 49 wherein the substrate comprises a quartz mass having a phase shifting layer thereover, wherein the opening formed in the second feature pattern location extends through the phase shifting layer and to the quartz mass; and wherein the dopant is implanted into the quartz mass of the second feature pattern location and into the phase shifting layer of the second rim location.

52. The method of claim 51 wherein the phase shifting layer comprises molybdenum and silicon.

53. A method of forming a radiation patterning tool, comprising:

providing a substrate; the substrate comprising a mass transparent to a wavelength of light, and comprising a layer opaque to the wavelength of light over the mass;

forming a layer of photoresist over the opaque material; a first portion of the photoresist being over a first defined feature pattern location, a second portion of the photoresist being over a first defined rim location; a third portion of the photoresist being over a second defined feature pattern location, and a fourth portion of the photoresist being over a second defined rim location;

removing the first and fourth portions of the photoresist to expose segments of the layer in the first feature pattern location and second rim location;

removing the exposed segments of the layer from the first feature pattern location and second rim location;

after removing the exposed segments of the layer, implanting dopant into the substrate in the first feature pattern location and second rim location;

after implanting the dopant, removing the second and third portions of the photoresist to expose segments of the layer in the first rim location and second feature pattern location;

removing the exposed segments of the layer from the first rim location and second feature pattern location; and

wherein:

the doped region of the first feature pattern location is comprised by a first feature pattern configured to impart a first rotation in phase to the wavelength of light when the wavelength passes through the first feature

pattern;

the first rim location comprises a first rim along a portion of the first feature pattern and configured to impart a second rotation in phase to the wavelength of light when the wavelength passes through the first rim; the second rotation in phase being from about 170 degrees to about 190 degrees relative to the first rotation in phase;

the second feature pattern location comprises a second feature pattern configured to impart a third rotation in phase to the wavelength of light passing through the second feature pattern; the third rotation in phase being from about 170 degrees to about 190 degrees relative to the first rotation in phase; and

the doped region of the second rim location is comprised by a second rim along a portion of the second feature pattern and configured to impart a fourth rotation in phase to the wavelength of light when the wavelength passes through the second rim; the fourth rotation in phase being from about 170 degrees to about 190 degrees relative to the third rotation in phase.

54. The method of claim 53 wherein the substrate consists essentially of quartz, and wherein the layer opaque to the wavelength is formed physically against the quartz of the substrate and comprises chromium.

55. The method of claim 53 wherein the dopant comprises boron, indium, arsenic, antimony or phosphorus.

56. A method of forming a radiation patterning tool, comprising:

providing a substrate; the substrate comprising a mass transparent to a wavelength of light, and comprising a layer opaque to the wavelength of light over the mass;

forming a layer of photoresist over the opaque material; a first portion of the photoresist being over a first defined feature pattern location, a second portion of the photoresist being over a first defined rim location; a third portion of the photoresist being over a second defined feature pattern location, and a fourth portion of the photoresist being over a second defined rim location;

removing the first and third portions of the photoresist to expose segments of the layer in the first and second feature pattern locations;

removing the exposed segments of the layer from the first and second feature pattern locations;

after removing the exposed segments of the layer from the first and second feature pattern locations, removing the second and fourth portions of the photoresist to expose segments of the layer from the first and second rim locations,

removing the exposed segments of the layer from the first and second rim locations;

after removing the exposed segments of the layer from the first and second rim locations; forming a photoresist mass over the first feature pattern location and first rim location;

after forming the photoresist mass, implanting dopant into the substrate in the second feature pattern location and second rim location;

after implanting the dopant, removing the photoresist mass; and

wherein:

the first feature pattern location comprises a first feature pattern configured to impart a first rotation in phase to the wavelength of light when the wavelength passes through the first feature pattern;

the first rim location comprises a first rim along a portion of the first feature pattern and configured to impart a second rotation in phase to the wavelength of light when the wavelength passes through the first rim; the second rotation in phase being from about 170 degrees to about 190 degrees relative to the first rotation in phase;

the doped second feature pattern location is comprised by a second feature pattern configured to impart a third rotation in phase to the wavelength of light passing through the second feature pattern; the third rotation in phase being from about 170 degrees to about 190 degrees relative to the first rotation in phase; and

the doped second rim location is comprised by a second rim along a portion of the second feature pattern and configured to impart a fourth rotation in phase to the wavelength of light when the wavelength passes through the second rim; the fourth rotation in phase being from about 170 degrees to about 190 degrees relative to the third rotation in phase.

57. The method of claim 53 wherein the substrate comprises a quartz mass having a phase shifting layer thereover, wherein the phase shifting layer comprises molybdenum and silicon, and wherein the layer opaque to the wavelength comprises chromium.

58. The method of claim 57 wherein the doped region of the second feature pattern location is within the quartz substrate, and wherein the doped region of the second rim location is within the phase shifting layer.

59. The method of claim 53 wherein the dopant comprises boron, indium, arsenic, antimony or phosphorus.

60. A method of forming a radiation patterning tool, comprising:

providing a substrate which includes a quartz base, a first phase shifting layer over the quartz base, a second phase shifting layer over the first phase shifting layer and having a different composition than the first phase shifting layer, and an opaque material over the second phase shifting layer;

etching a first pattern through the first phase shifting layer, second phase shifting layer, and opaque layer; the first pattern being a feature pattern; the feature pattern having a periphery and being configured to impart a first rotation in phase to wavelength of light passing through the feature pattern;

etching a second pattern through the opaque layer and the second phase shifting layer, and to the first phase shifting layer; the second pattern being a rim; the rim being along a portion of the feature pattern periphery but not along an entirety of the feature pattern periphery; the rim being configured to impart a second rotation in phase to the wavelength of light when the wavelength passes through the rim; the second rotation in phase being from about 170 degrees to about 190 degrees relative to the first rotation in phase.

61. The method of claim 60 wherein the etching to form the rim occurs simultaneously with the etching to form the feature pattern.

62. The method of claim 60 wherein the formation of the rim and feature pattern comprises:

forming a layer of photoresist over the opaque material; a first portion of the photoresist being over a defined feature pattern location, and a second portion of the photoresist being over a defined rim location;

reducing a thickness of the photoresist over the first portion relative to the second portion to form a stepped photoresist mask having a greater thickness over the rim location than over the feature pattern location;

subjecting the photoresist to an etch to remove the photoresist from over the feature pattern location while leaving the photoresist over the rim location, the removal of the photoresist from over the feature pattern location exposing a segment of the opaque layer;

etching into the feature pattern location to remove the exposed segment of the opaque layer and form a first opening extending into the feature pattern location;

extending the first opening through the second phase shifting layer;

after extending the first opening, removing the photoresist from over the rim location;

removing the opaque layer from over the rim pattern to form a second opening extending into the rim location; and

extending the first and second openings to form the feature pattern to extend through to the quartz substrate and form the rim to extend to the first phase shifting layer.

63. The method of claim 62 wherein the formation of the stepped photoresist mask comprises;

exposing the first and second portions of the photoresist to radiation, the first portion of the photoresist being exposed to a different dose of the radiation than the second portion of the photoresist;

subjecting the photoresist to a developing solution, the developing solution removing more of the photoresist from the first portion than from the second portion to form the stepped photoresist mask.

64. The method of claim 60 wherein the first phase shifting layer attenuates the light more than the second phase shifting layer.

65. The method of claim 60 wherein:

the first phase shifting layer comprises molybdenum and silicon; and

the second phase shifting layer comprises silicon and one or both of oxygen and nitrogen.

66. The method of claim 60 wherein the opaque layer comprises chromium.

67. The method of claim 60 wherein the second rotation in phase is about 180 degrees relative to the first rotation in phase.

68. The method of claim 60 wherein the feature pattern has a rectangular shape comprising two pairs of opposing sides, and wherein two of the rims are formed relative to the feature pattern; the two rims being provided along both opposing sides of one pair of the opposing sides of the rectangular shape.

69. The method of claim 60 wherein the feature pattern has a shape comprising a plurality of sides, and wherein there is no rim formed along at least one of the sides.

70. A method of forming a radiation patterning tool, comprising:

providing a substrate which includes a quartz base, a first phase shifting layer over the quartz base, a second phase shifting layer over the first phase shifting layer and having a different composition than the first phase shifting layer, and an opaque material over the second phase shifting layer;

etching a first pattern through the first phase shifting layer, second phase shifting layer, and opaque layer, and into the substrate; the first pattern being a feature pattern; the feature pattern having a periphery and being configured to impart a first rotation in phase to a wavelength of light passing through the feature pattern;

etching a second pattern through the opaque layer; the second pattern being a rim; the rim being along a portion of the feature pattern periphery but not along an entirety of the feature pattern periphery; the rim being configured to impart a second rotation in phase to the wavelength of light when the wavelength passes through the rim; the second rotation in phase being from about 170 degrees to about 190 degrees relative to the first rotation in phase.

71. The method of claim 70 wherein the formation of the rim and feature pattern comprises:

forming a layer of photoresist over the opaque material; a first portion of the photoresist being over a defined feature pattern location, and a second portion of the photoresist being over a defined rim location;

reducing a thickness of the photoresist over the first portion relative to the second portion to form a stepped photoresist mask having a greater thickness over the rim location than over the feature pattern location;

subjecting the photoresist to an etch to remove the photoresist from over the feature pattern location while leaving the photoresist over the rim location, the removal of the photoresist from over the feature pattern location exposing a segment of the opaque layer;

etching into the feature pattern location to remove the exposed segment of the opaque layer and form a first opening extending into the feature pattern location;

extending the first opening through the first and second phase shifting layers and into the substrate;

after extending the first opening, removing the photoresist from over the rim location; and

removing the opaque layer from over the rim pattern to form the rim extending through the opaque layer and to the second phase shifting layer.

72. The method of claim 71 wherein the formation of the stepped photoresist mask comprises;

exposing the first and second portions of the photoresist to radiation, the first portion of the photoresist being exposed to a different dose of the radiation than the second portion of the photoresist;

subjecting the photoresist to a developing solution, the developing solution removing more of the photoresist from the first portion than from the second portion to form the stepped photoresist mask.

73. The method of claim 70 wherein the first phase shifting layer attenuates the light more than the second phase shifting layer.

74. The method of claim 70 wherein:

the first phase shifting layer comprises molybdenum and silicon; and

the second phase shifting layer comprises silicon and one or both of oxygen and nitrogen.

75. The method of claim 70 wherein the opaque layer comprises chromium.

76. The method of claim 70 wherein the second rotation in phase is about 180 degrees relative to the first rotation in phase.

77. The method of claim 70 wherein the feature pattern has a rectangular shape comprising two pairs of opposing sides, and wherein two of the rims are formed relative to the feature pattern; the two rims being provided along both opposing sides of one pair of the opposing sides of the rectangular shape.

78. The method of claim 70 wherein the feature pattern has a shape comprising a plurality of sides, and wherein there is no rim formed along at least one of the sides.

79. A method of forming a radiation patterning tool, comprising:

providing a substrate which includes a quartz base, a first phase shifting layer over the quartz base, a second phase shifting layer over the first phase shifting layer and having a different composition than the first phase shifting layer, and an opaque material over the second phase shifting layer;

etching a first pattern through the first phase shifting layer, second phase shifting layer, and opaque layer, and into the substrate; the first pattern being a first feature pattern; the first feature pattern having a periphery and being configured to impart a first rotation in phase to a wavelength of light passing through the feature pattern;

etching a second pattern through the first phase shifting layer, second phase shifting layer, and opaque layer; the second pattern being a second feature pattern; the second feature pattern having a periphery and being configured to impart a second rotation in phase to a wavelength of light passing through the feature pattern; the second rotation in phase being from about 170 degrees to about 190 degrees relative to the first rotation in phase;

etching a third pattern through the opaque layer; the third pattern being a first rim; the first rim being along a portion of the first feature pattern periphery but not along an entirety of the first feature pattern periphery; the first rim being configured to impart a third rotation in phase to the wavelength of light when the wavelength passes through the first rim; the third rotation in phase being from about 170 degrees to about 190 degrees relative to the first rotation in phase; and

etching a fourth pattern through the opaque layer and the second phase shifting layer, and to the first phase shifting layer; the fourth pattern being

a second rim; the second rim being along a portion of the second feature pattern periphery but not along an entirety of the second feature pattern periphery; the second rim being configured to impart a fourth rotation in phase to the wavelength of light when the wavelength passes through the second rim; the fourth rotation in phase being from about 170 degrees to about 190 degrees relative to the second rotation in phase.

80. The method of claim 79 wherein the formation of the first rim and first feature pattern comprises:

forming a layer of photoresist over the opaque material; a first portion of the photoresist being over a defined first feature pattern location, and a second portion of the photoresist being over a defined first rim location;

reducing a thickness of the photoresist over the first portion relative to the second portion to form a stepped photoresist mask having a greater thickness over the first rim location than over the first feature pattern location;

subjecting the photoresist to an etch to remove the photoresist from over the first feature pattern location while leaving the photoresist over the first rim location, the removal of the photoresist from over the first feature pattern location exposing a segment of the opaque layer;

etching into the first feature pattern location to remove the exposed segment of the opaque layer and form a first opening extending into the first feature pattern location;

extending the first opening through the first and second phase shifting layers and into the substrate;

after extending the first opening, removing the photoresist from over the first rim location; and

removing the opaque layer from over the first rim pattern to form the first rim extending through the opaque layer and to the second phase shifting layer.

81. The method of claim 80 wherein the formation of the stepped photoresist mask comprises;

exposing the first and second portions of the photoresist to radiation, the first portion of the photoresist being exposed to a different dose of the radiation than the second portion of the photoresist;

subjecting the photoresist to a developing solution, the developing solution removing more of the photoresist from the first portion than from the second portion to form the stepped photoresist mask.

82. The method of claim 79 wherein the formation of the second rim and second feature pattern comprises:

forming a layer of photoresist over the opaque material; a first portion of the photoresist being over a defined second feature pattern location, and a second portion of the photoresist being over a defined second rim location;

reducing a thickness of the photoresist over the first portion relative to the second portion to form a stepped photoresist mask having a greater thickness over the second rim location than over the second feature pattern location;

subjecting the photoresist to an etch to remove the photoresist from over the second feature pattern location while leaving the photoresist over the second rim location, the removal of the photoresist from over the second feature pattern location exposing a segment of the opaque layer;

etching into the second feature pattern location to remove the exposed segment of the opaque layer and form a first opening extending into the second feature pattern location;

extending the first opening through the second phase shifting layer;

after extending the first opening, removing the photoresist from over the second rim location;

removing the opaque layer from over the second rim pattern to form a second opening extending into the second rim location; and

extending the first and second openings to form the second feature pattern to extend through to the quartz substrate and form the second rim to extend to the first phase shifting layer.

83. The method of claim 82 wherein the formation of the stepped photoresist mask comprises;

exposing the first and second portions of the photoresist to radiation, the first portion of the photoresist being exposed to a different dose of the radiation than the second portion of the photoresist;

subjecting the photoresist to a developing solution, the developing solution removing more of the photoresist from the first portion than from the second portion to form the stepped photoresist mask.

84. The method of claim 79 wherein the formation of the first feature pattern and second feature pattern comprises:

forming a patterned layer of photoresist over the opaque material; a portion of the photoresist being over a defined second feature pattern location, and a defined first feature location being exposed through an opening in the patterned photoresist;

while the patterned photoresist covers the second feature pattern location, etching into the first feature pattern location to remove a segment of the opaque layer and form a first opening extending into the first feature pattern location;

extending the first opening through the second phase shifting layer;

after extending the first opening, removing the photoresist from over the second feature pattern location;

removing the opaque layer from over the second feature pattern location to form a second opening extending into the second feature location; and

extending the first opening through the second phase shifting layer and into the substrate while extending the second opening through the first and second phase shifting layers and to the substrate.

85. The method of claim 79 wherein the first phase shifting layer attenuates the light more than the second phase shifting layer.

86. The method of claim 79 wherein:

the first phase shifting layer comprises molybdenum and silicon; and

the second phase shifting layer comprises silicon and one or both of oxygen and nitrogen.

87. The method of claim 79 wherein the opaque layer comprises chromium.

88. The method of claim 79 wherein the first and second feature patterns are arranged in rows and columns; wherein the first and second feature patterns alternate with one another along the rows of the array; and wherein the first and second rims are along columns of the array.

89. The method of claim 88 wherein the first and second feature patterns do not alternate with one another along the columns of the array.

90. The method of claim 88 wherein the first and second feature patterns alternate with one another along the columns of the array.

91. The method of claim 88 wherein the first and second feature patterns do not alternate with one another along the columns of the array, wherein adjacent feature patterns along the columns are separated from one another by a distance, and wherein the rims extend an entirety of the distance between adjacent feature patterns along the columns of the array.

92. The method of claim 88 further comprising forming a plurality of side-lobe-suppressing patterns between adjacent rims along columns of the array.

93. The method of claim 88 further comprising forming a plurality of side-lobe-suppressing patterns between adjacent rims along columns of the array; individual side-lobe-suppressing patterns being between adjacent rims along columns of the array; the individual side-lobe-suppressing patterns being configured to rotate the wavelength of light by from about 170 degrees to about 190 degrees relative to the rotation imparted to the light by the rims on either side of the individual side-lobe-suppressing patterns.

94. The method of claim 93 wherein adjacent rims along the columns of the array are separated from one another by a distance, and wherein the individual side-lobe-suppressing patterns are formed to extend an entirety of the distance between adjacent rims along the columns of the array.

95. The method of claim 93 wherein adjacent rims along the columns of the array are separated from one another by a distance, and wherein the individual side-lobe-suppressing patterns are formed to not extend an entirety of the distance between adjacent rims along the columns of the array.

96. The method of claim 88 wherein the first and second rims are not formed along rows of the array.